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ABSTRACT

This paper is part of a paper set which addresses the potential contributions of teacher effectiveness research to science teacher education. The goal of the study is to assess selected research-based teaching and observation practices in combination with an effective staff development procedure in the context of science education. Two techniques, "Active Teaching Behaviors (ATB)" and "Academic Learning Time (ALT)," were employed in classroom observation studies to explore their transferability potential to the teaching of high school science within the context of preservice teacher education. A case study of one of the project's participants, a student teacher assigned to a high school physics classroom, is presented. Areas provided in the case study include: (1) setting explanation; (2) verbatim excerpts from an interview; (3) discussion and reaction to ATB coding; (4) cooperating teacher's feedback; and (5) an interpretive summary. Tables of data on ATB from the observed lessons are also provided. (ML)

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Active Teaching Behaviors in Secondary Science Teaching: Case Study of a Student Teacher

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Active Teaching Behaviors in Secondary Science Teaching: Case Study of a Student Teacher

This paper is one in a set of three papers reporting a study designed to explore the potential contribution of teacher effectiveness research to science teacher education, by providing training to pairs of cooperating and student teachers. This paper constructs a case-study portrait of the experiences of one student teacher, while the paper by Ponzio and Russell describes the background to the study and that by Bowyer presents an analysis of the participants' reactions to the training and the opportunity to talk about and apply ideas based in classroom research.

Introduction

A recent study of preservice teacher education (Griffin et al., 1983) found that cooperating teachers and student teachers were unaware, for the most part, of the results of teacher effectiveness research. Only occasionally did teaching practices coincide with those that have been found to correlate with higher student achievement, and discussions of teaching behaviors rarely involved research-based criteria. This apparent gap between research findings and teacher education practices is the focus of the present study. The overall goal of the study was to assess the potential of research-based teaching and observation practices in combination with an effective staff development procedure, in the context of science education.

A review of recent research on teacher effectiveness (described in the accompanying paper by Ponzio and Russell) yielded two perspectives that seemed promising as ways to observe in classrooms and to stimulate thought about teaching. One classifies teaching behaviors, while the second attends to student behaviors; both have been found to correlate with increased student achievement on standardized tests in math and reading at the elementary level. Good's (1979) model of "direct instruction" was used to develop a set of "Active Teaching Behaviors" based on studies of mathematics teaching (Good et al., 1983). The construct of "Academic Learning Time" (from the Beginning Teacher Evaluation Study, Fisher et al., 1980) provides a "proxy" for direct measurement of student achievement, one that can be used on a daily basis by a classroom observer. This study explores the transferability of these findings to the teaching of high-school science, within the context of preservice teacher education.

The investigators provided training to pairs of cooperating and student teachers, to enable them to observe each other. Three secondary science student teachers enrolled in a "fifth-year" preservice teacher education program and their cooperating teachers were trained in the coding of Academic Learning Time and Active Teaching Behaviors. Approximately one hour of training was provided in the use of each form, and a third hour was devoted to a general discussion of the purposes of the study. Observation forms were provided to the participants, for use in their classrooms and their supervisory conferences.

This paper is a case study of one of the six participants, a student teacher assigned to a high school physics classroom. A variety of circumstances contributed to our obtaining several different types of data. The cooperating teacher provided feedback in writing, and 30 of these brief reports were made available to the investigators. Four physics lessons, including three on successive days, were coded for Active Teaching Behaviors; one lesson was tape recorded. Finally, at the end of the study, the student teacher agreed to a tape-recorded interview concerning her work with her cooperating teacher and with the ideas associated with the study.

The Setting

The student teacher, Ms. Arlington, is in her late twenties; she has a strong background in physics and chemistry. Having enrolled in a teacher education program near her home and former high school, she inquired about doing her first practice teaching assignment at that school with Mr. Patterson, who had been her physics teacher. Arrangements were made for Ms. Arlington to be Mr. Patterson's first student teacher during the fall semester. Ms. Arlington began her teaching experiences gradually, working first with one class and later working with two classes on a daily basis. Several weeks after Ms. Arlington began her placement, she and Mr. Patterson were approached by the investigators to see if they would participate in the study. Mr. Patterson had heard about another teacher who used an observation form in his classroom and seemed interested in the general idea behind the study.

Following the training program, one of the investigators visited Mr. Patterson and Ms. Arlington on four different occasions to assess their responses to the project, to answer any questions, and to assist in data collection. During those visits, he coded Active Teaching Behaviors for Ms. Arlington. It became apparent that Mr. Patterson was more interested in the ALT--Academic Learning Time coding form, while Ms. Arlington was more interested in coding for ATB--Active Teaching Behaviors. (This is a preference difference that we have noticed occurs generally between cooperating teachers and student teachers.) Ms. Arlington coded Active Teaching Behaviors during Mr. Patterson's lessons, but they did not discuss the coding afterwards.

Mr. Patterson attempted to code for Academic Learning Time during Ms. Arlington's lessons, but he found himself frustrated by the form itself. He felt reluctant to move about the room and look over students' shoulders (to judge accuracy) as this would, he felt, change their behavior. Nor was he content to limit his attention to only four students. He found that he could go through the class very quickly, tallying what everyone was doing, tallying the "not engaged" students within 15 to 20 seconds. This procedure seems to require less work and produce more useful information. He noted categories such as "eyes closed," "writing," and "looking elsewhere." (For the first time, he sat at the front of the room while Ms. Arlington taught, so that he could see the students' faces. At no point were the coding forms explained to the students, although Ms. Arlington raised this

possibility.) Thus Mr. Patterson's reaction to the ALT form was to shift from coding engagement and accuracy for four students at two-minute intervals to coding types of non-engagement for all students in the room in a short space of time. But even this adaptation did not strike him as particularly informative, and he soon appeared to lose interest in the forms.

The larger story to be told is the one from Ms. Arlington's point of view. She experienced the tension between her cooperating teacher's apparent lack of interest in the use of the forms and the arrival of someone from her college program who used one of the forms on each visit and seemed to take the forms quite seriously. Mr. Patterson showed no interest in the coding of ATB for Ms. Arlington's teaching, and he found other things to do while Ms. Arlington and I discussed the forms after each lesson that was coded. The presentation of Ms. Arlington's experience of the study begins with the final interview, which serves to establish several major themes for reviewing the other types of data that were collected. A summary of the coding of Active Teaching Behaviors indicates how her lessons varied over four lessons. An excerpt from one lesson illustrates how a verbatim transcription relates to information obtained by coding. Finally, an analysis of the written feedback regularly provided to Ms. Arlington by Mr. Patterson provides a basis for interpreting the fact that coding for Active Teaching Behaviors and Academic Learning Time never really "caught on" in this setting.

Ms. Arlington's Final Interview

The following quotations are verbatim excerpts from an interview with Ms. Arlington shortly after she completed her practice teaching assignment with Mr. Patterson. Four themes are developed: (1) Ms. Arlington's account of the basic supervisory style used by Mr. Patterson, (2) Ms. Arlington's reactions to the information on coding sheets for Active Teaching Behaviors, (3) her impressions of Mr. Patterson's reactions to the Active Teaching Behaviors concepts, and (4) her experience attempting something new in the classroom.

Basic supervisory style

In the first excerpt, Ms. Arlington explains her reaction to Mr. Patterson's procedure of writing out comments as he observed her teaching. The letter Q identifies the interviewer's questions; the letter A identifies Ms. Arlington's answers.

Q: So you had daily sheets of right and wrong. How useful did you find those?

A: Some things were nice. I wish. . . actually, I wish he had told me to my face instead. . . He would leave them on the back table, (laughs) telling you to go back and get them, and he usually walked out.

Q: And he would ask if you'd seen it?

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A: Yes. You know, it was really bad because sometimes he would. . . he would write a criticism for something that I did and I wanted to tell him, "Well, that's exactly what you did." But I didn't get a chance. And rarely, did I get a chance to ask him how can I improve what I did wrong.

Q: O.K., so it seems to me about right there we've got a signal as to why this particular project didn't go very far. It seems like he's not very inclined to sitting down and talking about detailed events.

A: O.K., that is true. . . The only time we ever got. . . well, we never got specific about my teaching until, maybe, this past Thursday, and it wasn't about my teaching, but about his. . . . When we talked on Thursday, I asked him if he was preoccupied. I always got this feeling that I would say something and that he didn't really hear me. Like, one time I actually told him I needed help, that I couldn't deal with it, and I was going through finals, and then he goes, "O.K., I'll help you," and he walked out the door, and I was, like, "O.K., fine, I won't ask you any more." And so I later told him that that really bothered me and that I. . . you know, it really upset me a lot, and he didn't even remember it at all.

Reaction to ATB coding

When Ms. Arlington was coded for Active Teaching Behaviors (ATB) during four lessons, she was given the coded sheets immediately afterwards, and she seems to have examined them with some care and interest. She explains that the sheets gave her some indication that what she was doing corresponded to her plans. The data made it obvious that she was devoting little time to her lesson introductions and virtually none to closure of the lesson. She indicates that she hopes to change these aspects of her teaching in her next placement.

Q: I'd be interested in your impression of the form as a way of collecting data about what happens in a classroom. . . .

A: Well, I liked [having the Active Teaching Behaviors] you did on me. I thought it was really nice. Appreciate it. I thought it was really useful.

Q: How was it useful?

A: One day you came in when I did a problem set, a review of a problem, so I knew what I wanted to do, and looking at it I knew, I actually did it, I spent more time, like, answering questions.

A: For instance, if I went in there with the goal of giving instructions . . . then I was able to look at this and see, well, [did] I spend the majority of my time doing that?

Q: So, "did I do what I planned to do?"

A: Yes. And I thought that was really nice. And then it was nice to see that. . . you see, I never did a closure hardly, which is something I'd really like to work on; and introduction I'd like to work on too. . . .

Q: Do you feel that you want to work on them because they're there on the form and. . . and somehow that implies that they're necessary? Or is it just having had those terms called to your attention? "Oh! Maybe, I should do more of that?"

A: Basically because I think that it's nice to have an introduction. . . it's nice, I think, when you go into a lecture and have the teacher that kind of summarizes what you've done so far. You know, O.K., this is how we're going to. . . what we're going to do today and how it relates to what we did yesterday, to tie it all in so it all makes sense. So that's why I'd like to do an introduction; and then a closure. . . I just didn't like the feeling of the bell just ringing or it just ending. I don't like that. . . .

Q: The basic thing that I've got from this so far is that you felt these sheets had some potential, and we've talked about what it was. Do you think you. . . that anything at all changed about your teaching as a result of having been exposed to the concept [of Active Teaching Behaviors], or having me there marking them, and giving these to you each day.

A: No. I wish I was more organized and had things better planned, but I just didn't have the time for it. Umm, as far as this helping me, I think it'll help. It helped me, like, in my last week, because I went over these and I saw certain things that I was doing and. . . and this kind of helped me to be more confident with what I was doing because I thought. . . I saw I was doing what I wanted to be doing, so that was kind of nice. . . That's probably the main thing that came out of it. I don't think I really want. . . changed anything because of it.

Q: So basically you're saying you. . . you liked what you saw you were doing. You'd been left on your own to make your own decisions about what should happen in the class, and you didn't see any things on here that horrified you?

A: No, not really.

Q: And you were also then left with the impression that introduction and closure are things you'd like to work on.

A: Mmhmm. (Later in the interview) I plan to really try to do it, to make an effort to do it because I can think it's important, and I've heard a lot of people, teachers, saying it's important. I observed some teachers in the last week. I spent some time going around and I noticed that they did it, the teachers that I really liked, that I was impressed with, had an introduction and a closure.

Mr. Patterson's reaction to ATB

In a very brief comment, Ms. Arlington indicated that her cooperating teacher found the Active Teaching Behavior forms "interesting" but not "useful."

A: It's useful for me. As far as, I don't know if I should speak for Mr. Patterson, . . . but he never. . . he didn't like. . . he didn't feel it was useful, and so it was just kind of interesting. . . . He just sat there. . . we sat here one day for two hours looking at this form, but he just never was interested. But I told him that I felt that we should talk about it.

Attempting an innovation

In the final excerpt, Ms. Arlington explains how her cooperating teacher reacted when she tried "something different" in one of her classes, without the encouragement and prior approval of Mr. Patterson.

A: Another thing I tried was playing games with them. You know, I tried in the classroom "reverse checkers" and things like that and he told me that he would never, ever, ever do that with his classes, that he would just lose total control. You know. . . one day it turned out really, really nicely. When you read those little comments from him I'll point it out to you. Well, you'll see it, that he was really surprised. I told those that wanted to play games to come to the front, and those that didn't want to to study at the back and he told me. . . he walked up right then and there, and he said,"You've got total chaos", and I said, "Well, I'm going to do it." And it turned out really well, and it surprised him and actually it surprised me but that was really nice.

The general picture painted in these comments is not one indicative of support for Ms. Arlington in any experiments with innovative teaching. She seems to have been interested in the data that could be gathered by coding for Active Teaching Behaviors, but she found no support from her cooperating teacher. Mr. Patterson was not accustomed to detailed analysis of classroom events, and he conveyed his comments to Ms. Arlington in writing. These excerpts do not contain information about the overall satisfaction Ms. Arlington felt in this placement. She and her cooperating teaching spent many hours talking about broader issues in education, and she drew confidence from the experience of returning to her former high school for her first practice teaching placement. She was his first student teacher; he, her first cooperating teaching. Although their relationship had both positive and negative aspects, they both seemed pleased with the time they had spent working together. The coding of ATB and ALT began after they had established their basic relationship.

Active Teaching Behaviors in Four Physics Lessons

The concept of Active Teaching Behaviors is drawn from the work of Good et al. (1979, 1983) but the coding sheet used in this study is one developed quite independently of Good, for use in the Far West Laboratory's study of the application of research to teacher education at the elementary level. The sheet contains 20 specific teaching behaviors in four broad categories--introduction, instruction, closure, and maintenance--as listed in Table 1. During each minute of coding, the observer enters segments of the classroom dialogue and then selects one of the 20 categories as the predominant teacher behavior during that minute. However, when a behavior not already coded is observed, it is selected even if it is not predominant in the one-minute interval.

From the chart in Table 1, it is immediately obvious that introduction behaviors (5%) and closure behaviors (0.5%) were rarely observed. Introduction behaviors ranged from one to four per lesson; only one closure behavior was noted during the four lessons. Maintenance behaviors were 13% of the total, with "roaming the room" and "scanning the room" accounting for all but 3 of the 23 behaviors. Instruction behaviors were 81.5% of the total, and a brief account of each of the four lessons is helpful in interpreting the variations in this category.

Lesson I: After a brief discussion of homework problems, the teacher explains a rather complicated lab activity concerning the orbit of Mars, giving directions and posing questions about what is expected. As the students do the lab activity, the teacher responds to their questions about its content and procedures.

Lesson II: The teacher develops the Law of Universal Gravitation and then guides students through a problem set by posing questions and by responding to students' questions.

Lesson III: After giving directions for a field trip, the teacher discusses problems requested by students, using a questioning strategy ("What are they asking you for?" "What values are given?"). A complicated problem is explained and then a brief reading is assigned and questions are asked about it.

Lesson IV: Students copy hints for doing the homework and the teacher explains how to review a chapter in the text. In the second half of the lesson, students work at their seats and the teacher answers individual questions.

The summary of instructional behaviors at the bottom of Table 1 reveals some of the variations across these four lessons. "Giving directions" (5) was more much apparent in Lessons I and II, while "Lecturing" (6 & 7) was much more in evidence in Lessons III and IV. "Questioning" (8 & 9) was high in Lesson II and particularly high in Lesson III. "Answering" (10 & 11) was very high in Lesson IV and significant in Lessons I and II. "Feedback" (12) was noted only once in the four lessons. The variations among directions, lecture,

questioning, and answering match the brief descriptions of each lesson. One interpretation of the predominance of these four sets of teaching behaviors is that these are the four activities most obvious in any teacher's behavior. It is not surprising that a beginning science teacher would use these; only time will tell whether other behaviors increase with further practice. One value of the set of 20 categories is its potential to indicate that there are possible teaching behaviors that are not being used significantly. (The form provides no simple conclusions about how teaching should be changed; the teacher must judge whether behaviors not used would be appropriate.) In this instance, the cooperating teacher did not pick up on this possible feedback strategy. Ms. Arlington herself noticed that other teachers use introduction and closure behaviors and thought that she would try to use them more.

Comparing ATB Coding to Verbatim Transcription

A transcription of a ten-minute excerpt from Lesson III appears in Table 2, which provides an illustration of the differences between ATB coding and verbatim transcription of a tape recording of a lesson. Thus far the reader has "met" Ms. Arlington in the transcribed excerpts from the final interview; this transcription provides a glimpse of Ms. Arlington at work in her classroom. The parallel presentation of ATB coding and transcription illustrates the application of the ATB categories to the verbal component of the teacher's classroom behaviors. The main purpose of this presentation of data is to add detail and meaning to what has preceded.

The most obvious difference between the two procedures for collecting data about the lesson is that of detail, paid for in the time required to produce the transcription of the tape. The ATB codings are available immediately after the lesson finishes, but they are all that is available. The observer's accompanying description is little more than a reminder of what was happening in the minute that a particular category was checked. The transcription might be available the next day, with considerable overnight effort, but one would not be likely to make such an effort on a daily basis for supervisory purposes. The transcription is not coded for anything in particular; it is then possible to code it from a number of perspectives, including ATB if one wishes. Each such coding, or attempt to find patterns in the transcription, requires additional time.

In this transcription, Ms. Arlington is solving a problem that students have attempted as homework. The basic strategy of working through a problem by posing questions about each part is evident in the number of times (five) that "9: Questioned for facts" was coded. There is one interval (1305) in which the questions relate more to students' understanding, and an "8" is coded. In another interval (1306), the teacher is answering a student's question about content ("10"), and in yet another, the teacher scans the room ("19") as students read. Finally, there are two intervals (1307 and 1310) when Ms. Arlington is illustrating an answer with reference to diagrams, showing just how a particular conclusion follows from the examples that have been used.

Cooperating Teacher's Daily Feedback

In addition to their lengthy conversations about broad issues in education, the supervisory relationship included written comments from Mr. Patterson to Ms. Arlington. As noted previously in the discussion of Mr. Patterson's basic supervisory style, as described by Ms. Arlington in her interview, these written comments were left on a table, and Ms. Arlington found it less than ideal that they were not discussed regularly and in detail. An example of one day's feedback is illustrative of the types of comments that were made; this feedback is that provided on the day that Lesson III was t. t. The comments have been numbered for later reference.

1. Giving the class a choice about open book vs closed book on the multiple-choice exam is a nice way of helping them assume more responsibility for their education.
2. You became irritated at class noise a little more quickly than usual. (I realize it's pretty threatening with two of us back here watching you.) An "I" message (Teacher Effectiveness) would have been nice.
3. I suspect teaching students how to use their scientific calculators [e.g. square roots, cube roots] is worthwhile. You might ask how many know how to do a particular type of operation as occasion arises & then decide if it's worthwhile.
4. Your use of the diagrams & descriptions of Cavendish's apparatus on p. 231. I can probably explain how Cavendish found the force with his torsion balance: [set of equations follows].
5. It is important, in the long run, to be very persistent in asking students to sit down & study during study-time.

There are no obvious connections between the content of these remarks and the content of the excerpt from Lesson III. Nor would it be appropriate to generalize from one lesson excerpt and one sample of feedback to any conclusions about the specific style of feedback used by Mr. Patterson. As noted, the lessons coded for Academic Teaching Behaviors occurred in the later weeks of this practice teaching placement. Ms. Arlington did give permission for examination of 30 pieces of daily written feedback that spanned the entire placement, and it is interesting to note the results of a content analysis of those pieces of feedback. There were 129 separate statements, and these were studied at length until a basic set of interpretive categories emerged that permitted the statements to be assigned to one of six classes: "praise" statements applauded specific teaching behaviors; "do" statements asked Ms. Arlington to make a specific change; "hints" were suggestions for future teaching behavior, not direct requests for changes; "content comments" referred to the subject matter being taught; "behavior-effect" statements linked teaching behaviors to effects on students; "questions/comments" were inquiries or asides. The numerical results are presented in Table 3.

In this scheme, statement 1 in the sample above is a "praise" statement, statements 2, 3, and 5 are "hints," and statement 4 is a "content comment." The following statements are illustrative of the

other categories:

"Do": Wait for class to quiet before you begin teaching.

"Behavior-effect": Part of your discipline problem with this class is that you joke with them. You did this about 10 seconds after getting their attention, and I sensed an immediate loss of seriousness and increase in student noise level.

"Question/comment": Lab 7 will retrace Kepler's discovery of the elliptical shape of planetary orbits.

It is interesting to note the distribution of the various types of statements over the sequence of 30 lessons for which written feedback was provided. Fifty per cent of the "praise" and "do" statements were made in the first eight lessons. "Hints" tended to come later, with 50 per cent following the eighteenth lesson. "Content comments" tended to come later in the sequence, and this was even more the case with "behavior-effect" statements, five of which appeared in the last six lessons. This written record over an extended practicum placement provided a valuable opportunity to study the evolution of a cooperating teacher's feedback style. Just over 50 per cent of the written statements requested ("do") or suggested ("hints") changes by Ms. Arlington, without provision of the rationale that was characteristic of the "behavior-effect" statements.

Interpretive Summary

The process of coding Active Teaching Behaviors in four of Ms. Arlington's physics lessons ultimately yielded more data than the ATB frequency counts. Ms. Arlington agreed to be interviewed about her experiences in this practicum placement, her first, and the interview produced valuable insights into her reactions to the ATB ideas and data. Her consent to a tape recording of one lesson permitted a comparison of the ATB codings with a verbatim transcription, and her consent to an analysis of the written feedback she received provided clues to the basic supervisory style used by Mr. Patterson, her cooperating teacher.

Clearly, there is no basis for claiming changes in Ms. Arlington's teaching as a direct result of her brief training in the ideas of "active teaching" or "direct instruction." But it is important to note that she did find the ATB codings relevant. She interpreted them as telling her that she was doing the things she planned to do. She had enough experience to know that what happens is not always what was planned, and she valued the confirmation that teaching matched planning. She also concluded from the ATB codings that more attention to "introduction" and "closure" would be desirable. When she observed several other teachers in the school just before she completed this placement, she seems to have been guided by the issues of introduction and closure, noticing that the teachers did seem to be using those categories of teaching behavior.

It is readily apparent from the several types of data described in this case study that Ms. Arlington received little direct support in use of the ATB ideas from her cooperating teacher. Whatever attracted Mr. Patterson to agree to participate in the project seems not to have been delivered. He did not code Active Teacher Behaviors for Ms. Arlington, he was not interested in discussing her coding of his teaching, and he

did not find the Academic Learning Time coding format an informative one. More broadly, his basic supervisory style did not lend itself to incorporating the information provided by the coding sheets. He seems to have avoided direct discussion of specific teaching events. The feedback he did provide was written, with little oppo tunity for Ms. Arlington to clarify or question the comments. Half of the written feedback requested or suggested changes, with only limited reference to the rationale for the changes.

Ms. Arlington illustrates our broader experience that student teachers tend to find the Active Teaching Behavior categories interesting and informative, indicative of ways to broaden their initial range of behaviors, and of reasons for doing so. Mr. Patterson illustrates the significance of the cooperating teacher in any attempt to introduce the results of research on teacher effectiveness into practice teaching settings. He did not incorporate the ATB or ALT codings into his supervision of Ms. Arlington, and this created a not-unfamiliar tension between the practicum and the formal teacher education program of which the practicum is such a significant part.

Schön (1983) has argued that the work of highly successful practitioners is characterized by a process he terms "reflection-in-action," involving attention to puzzling events of practice, with special consideration of the framing of problems. Teacher education and classroom research have provided few details about how the "knowledge-in-action" of experienced teachers develops from the initial experiences of a student teacher to the final years of a teacher nearing retirement. The data assembled in this case study confirm yet again that the practicum setting tends not to focus on fine-grained analysis of events, to which teacher effectiveness research findings could contribute. The challenge of developing such a setting lies before us and Schön's concepts may prove helpful.

Although we cannot conclude from this limited experience that the research on teacher effectiveness that has been conducted at the elementary level has direct application at the secondary level in science classes, we are encouraged by the results of this preliminary exploration. Cooperating teachers seemed to welcome the opportunity to examine research findings, even if they did not find them easy to incorporate. Student teachers showed interest in "active teaching"; with their natural focus on their own behavior and with the difficulties of judging accuracy of engaged students in high school settings, the "academic learning time" idea proved more difficult. Finally, it is worth noting that there seem to be significant parallels between the "more effective teaching behaviors" that are emerging currently from classroom research, the "better science curricula" that were pressed upon science teachers in the 1960s, and the "better teaching methods" that have been advocated for decades. Yet again we see that science teaching is not amenable to rapid change. We are grateful to Ms. Arlington and Mr. Patterson for working with us and sharing the data that gave us initial insights into the potential application of the "active teaching" and "academic learning time" perspectives in the teaching of science at the secondary level.

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Table 1
ACTIVE TEACHING BEHAVIORS IN FOUR PHYSICS LESSONS

Active Teaching Behavior Categories

1. Stated goals, objectives
2. Outlined lesson
3. Explained concepts, definitions
4. Reviewed goals/previous instruction
5. Gave directions
6. Lectured, didactic
7. Illustrated, modeled, demonstrated
8. Questioned for understanding
9. Questioned for facts
10. Answered content questions
11. Answered procedural questions
12. Provided feedback
13. Summarized lesson/work
14. Collected work
15. Restated class rules
16. Told to attend
17. Roamed room
18. Signalled (non-verbal)
19. Scanned room
20. Disciplined

	INTRODUCTION				INSTRUCTION								CLOSURE		MAINTENANCE						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
LESSON																					
I	1	0	0	0	18	1	2	1	5	4	4	0	0	0	0	0	5	0	4	0	45
II	1	0	2	1	11	1	0	10	0	5	4	1	0	1	0	0	1	0	1	0	39
III	0	2	0	0	4	3	6	8	12	4	1	0	0	0	1	1	1	0	4	0	47
IV	0	2	0	0	4	8	0	3	0	20*	5	0	0	0	1	0	2	0	2	0	47
	2	4	2	1	37	13	8	22	17	33	14	1	0	1	2	1	9	0	12	0	
	9				145								1		23						178
	5.0%				81.5%								0.5%		13.0%						100%

FREQUENT BEHAVIORS (8 or more per lesson)

by Lesson		by Behavior		
I	5	5	I,II	Gave directions
II	5, 8	6	IV	Lectured
III	8, 9	8	II,III	Questioned for understanding
IV	6, 10*	9	III	Questioned for facts
		10	IV	Answered content questions

OCCASIONAL BEHAVIORS: 7, 11, 17, 19
INFREQUENT BEHAVIORS: 1, 2, 3, 4, 12, 13, 14, 15, 16, 18, 20

SUMMARY OF INSTRUCTIONAL BEHAVIORS

	5 Directions	6+7 Lecture	8+9 Questioning	10+11 Answering	12 Feedback
Lesson I	18	3	6	8	0
Lesson II	11	1	10	9	1
Lesson III	4	9	20	5	0
Lesson IV	4	8	3	25*	0

* 18 occurrences of 10 in last 19 minutes of Lesson IV; teacher is answering individual students' questions as all students review for test.

Table 2
Comparison of ATB Coding and Verbatim Transcription

Time and ATB CODE		TRANSCRIPTION Excerpt from Lesson III
1252		Lesson begins
1302	T:	O.K., let's consider Neptune only. What were you supposed to do? What did I tell you to do for this problem? Chris?
	M:	Find K.
[9]	T:	Find the value for K. (writing) K is equal to what? What values do you have? . . . (writing, as F quietly supplies data) O.K., what is the value for p?
1303	F:	174.783.
	T:	174.783? What were the units?
	F:	Years.
	T:	O.K., and R av?
	F:	30.07 (T writes) . . . years, I mean a.u.
[9]	T:	A.u.? Everybody got that, straight out of the chart. O.K., what equation can I use, if I want to solve for K and I'm given the values for period and the average r?
	F:	T squared over R to the third a v. (T writes)
	T:	T squared over R av cubed, equals what?
	F:	equals K.
1304	T:	equals K. How do you know that?
	F:	(inaudible)
	T:	How did we know this? Jeanette?
	F:	From the other equation that says T squared equals K times R cubed a v.
	T:	O.K., what is that called, T squared . . .
[8]	F:	(inaudible)
	T:	The law of periods. Did anybody have problems deriving this equation from the law of periods? . . . O.K., good, let's substitute the values in, solve for K, we get T = 164.783 over 30.07 cubed . . . Does that look right?
	F:	Uhuh.
	T:	Good? (Several students speak) One person.
	M:	You got to square the 164 . . .
1305	T:	Oh, because that's squared? O.K., so we'll square that. What about the units? What units do I have?
	F:	(inaudible)
	T:	Years squared over a.u. cubed. . . . And when you work out the math what do you get?
	M:	Point 9 9 8 6 7 5 0 1
[9]	T:	Units?
	M:	Years squared over a.u. cubed.
	T:	Everybody agree with that? . . . And when you did it for Uranus and Pluto you got approximately the same value. It was approximately equal to 1. So does Kepler's Law of Periods hold true? . . . (yes) O.K.?
1306	F:	[calls T] (T: Yes) In Chapters 7 and 8 I get confused on why they put the whole idea of a constant in. Is that why they call it a constant? Like that capital G?
[10]	T:	It makes a proportionality into an equality. That's what

happens. I think what you're asking me is why the k is equal to 1 for the planets going around the sun and why k is equal to something else for a satellite going around Jupiter.

1307 F: Yes, (inaudible)

[7] T: O.K., what happens . . . (raises board) is k holds true, you get one val, let's say you have the sun here and the planets going around. Kepler's Law of Periods says that's true, you're going to get <u>one</u> value for k, right, you get k is equal to a constant . . . for the planets going around the sun. O.K.? Now let's take Jupiter. We have four satellites going around. k is equal to a constant also. These constants aren't necessarily equal to each other though.

F: But . . . that constant . . . a number . . . should be the same.

T: Yes, what we did in 23 part c.

F: (inaudible)

1308 T: Do you understand now? Are there any questions on that? . .

[19] Could you read problem 23, part b? (Students read for 35 seconds) Let's consider satellite one only, and the drawing looks something like . . . like that.

1309 T: (Draws) In part b, what are you supposed to look for? Amy?

F: (inaudible)

[9] T: O.K., what's the symbol for period?

F: T

T: T, and R av. (writes) Straightforward . . ., it says it right there. How do you go about finding the period? . .

F: (inaudible)

1310 T: O.K., you start here, at the beginning of one cycle, keep going, count the number of days, down to where you run out of cycles, which on my diagram would be from here to here. Count the number of days, divided by the number of cycles. Chris?

M: How long is a cycle?

[7] T: How long is a cycle? On here, you start here and end here (referring to diagram on board). (M: Oh, O.K.) One cycle, two, . . . three. O.K.? (To cooperating teacher: Could I ask a question? Where's some more chalk?) (CT: I was wondering the same thing myself [goes to find chalk]) O.K., how do you find R av? No one knows? Chris?

M: Don't you take the . . . measure the distance from that middle line to the farthest point away . . .

1311 T: From here to where?

M: (inaudible)

T: To here, O.K., right. Does everybody follow that? . . . No? . . . everybody take their little ruler. What value do you get for R av for satellite number 1? . . . (F: inaudible) How many?

F: (inaudible)

[9] T: Zero point two five centimeters (writing) What value did you get for the period?

S: (inaudible)

T: One point seven five eight. O.K., that's how you find R av and the period? Any questions on that?

1312 Lesson continues to 1338

Table 3

Classification of 129 Feedback Statements
Written over 30 Lessons

Praise	40
Do-Statements	39
Hints	26
Content comments	11
Behavior-effect	7
Questions/comments	6

END

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